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(71) Applicant: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(72) Inventors: **WAJS, Julien**; 13, les Cottage, F-95330 Domont (FR). **THIOLIERE, Stephane**; 7 Square de Versailles, Le grandes Terres, F-78160 Marly le Roi (FR).

(74) Agents: **ALEANDRI-HACHGENEI, Lorraine** et al.; Office of Intellectual Property Counsel, 3M Deutschland GmbH, Carl-Schurz-Strasse 1, 41453 Neuss (DE).

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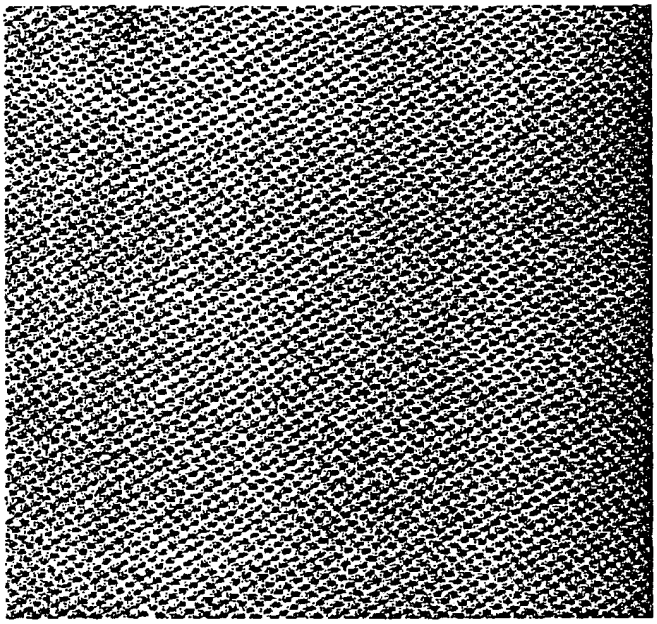
(54) Title: KNITTED MICROFIBER CLEANING CLOTH



(57) **Abstract:** A knitted microfiber cleaning cloth as well as a cleaning article, a cleaning pad and a cleaning implement comprising such a knitted microfiber cleaning cloth are described. The cleaning cloth is a microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern. A piqué knitting pattern is understood to be a knitting pattern which yields a knitted cloth having, on at least one side of the knitted cloth, a waffle-patterned structure.

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Knitted Microfiber Cleaning Cloth

Field of the Invention

The present invention relates to a knitted microfiber cleaning cloth as well as a cleaning article and a cleaning pad comprising such a knitted microfiber cleaning cloth. The present invention also relates to a cleaning implement as well as a kit comprising such a knitted microfiber cleaning cloth. The present invention also relates to a method of cleaning a surface.

Background of the Invention

Microfiber cleaning cloths, i.e. cleaning cloths comprising microfibers (i.e. a fiber having a linear density of one (1) denier or less) are known in the art. Microfiber cleaning cloths are advantageous in that they typically exhibit good cleaning efficiency, e.g. picking up dust or dirt particles as well as the removal of oils, grease, fingerprints and the like, without the application of chemical cleansing agents. Typically such cloths are either woven or knitted. Knitting is generally preferred because the resulting knitted microber cleaning cloth is more elastic than a microfiber cleaning cloth prepared by weaving and the knitted microfiber cleaning cloth is, thus, easier to wring out during wet cleaning or wiping.

Although known knitted microfiber cleaning cloths exhibit a number of properties desirable for wet cleaning, such cleaning cloths typically exhibit a disadvantageously high drag during wet cleaning. This is especially true, when wet cleaning with such a cleaning cloth attached to a flat-headed mop or cleaning support of a cleaning implement, due to a corresponding large contact area between the wiping surface and the surface to be cleaned. It is to be appreciated that for the user, wet cleaning or mopping with a mop or a cleaning implement exhibiting high drag is particularly disadvantageous. For every push and pull movement the user makes with the mop or cleaning implement, the user must exert extra effort or force to overcome the drag at the contact area, and when the drag is high he must exert correspondingly more effort or force. Thus wet cleaning or mopping large surface areas with a mop or cleaning implement exhibiting high drag can quickly become exhausting for the user.

Summary of the Invention

Thus, there is an ongoing need for knitted microfiber cleaning cloths, which exhibit a desirably low drag during wet cleaning, while maintaining good cleaning efficiency.

It has been surprisingly found that very low drag together with good cleaning efficiency can be realized by providing a microfiber cleaning cloth knitted with a piqué knitting pattern, which provides a cloth having a waffle-patterned structure, i.e. a structure having elevated portions in a form of a geometrical pattern with non-continuous depressions between said elevated portions.

Accordingly, the present invention provides a microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern.

In the present invention, a piqué knitting pattern is understood to be a knitting pattern, which yields a knitted cloth having, on at least one side of the knitted cloth, a waffle-patterned structure. The waffle-patterned structure may be based on any suitable geometrical pattern, preferably substantially honeycomb or round patterns, substantially square or rectangular patterns, substantially diamond patterns, substantially trapezoidal patterns or substantially triangular patterns. The geometrical pattern may be such that the depressions of the waffle-patterned structure are aligned or staggered.

Preferred piqué knitting patterns include Lacoste, Honeycomb, French piqué, Swiss piqué, single piqué and Ottoman-Honeycomb patterns, all of which are well known in the art. Among these patterns, Lacoste, Honeycomb and French piqué patterns are more preferred, while Lacoste and Honeycomb patterns even more preferred, and Lacoste pattern most preferred.

Also, it has been found that in order to realize desirably low drag, the entire microfiber cleaning cloth need not be knitted with one single piqué knitting pattern. Therefore, preferred embodiments of the invention include the provision of a

microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern and a second knitting pattern.

More particularly, it has been surprisingly found that advantageously low drag and high cleaning efficiency can be achieved by providing a microfiber cleaning cloth knitted with a mixed pattern of piqué knitting pattern with a second knitting pattern, which is not a piqué knitting pattern. Thus, more preferred embodiments of the invention include the provision of a microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern and a second knitting pattern, wherein said second knitting pattern is not a piqué knitting pattern.

Due to their advantageous cleaning properties, microfiber cleaning cloths according to the invention can be used for cleaning or wiping in wet state or also in dry or damp state as desired. Thus, the present invention provides a method of cleaning a surface comprising wiping the surface with a microfiber cleaning cloth of the invention. Microfiber cleaning cloths of the invention can be advantageously used as part of a cleaning article, e.g. cleaning pads, cleaning implements and the like. Accordingly an additional aspect of the invention is the provision of a cleaning article comprising a microfiber cleaning cloth according to the invention.

An additional aspect of the present invention is a method for the manufacture of a microfiber cleaning cloth comprising the step: knitting a cloth with a pattern comprising a piqué knitting pattern using at least one microfiber-containing yarn. In preferred embodiments of the method the pattern comprises a piqué knitting pattern and a second knitting pattern.

A further aspect of the invention is the provision of a cleaning pad comprising a wiping layer comprising a microfiber cleaning cloth according to the invention. In preferred embodiments, the cleaning pad further comprises a base layer adjacent to microfiber cleaning cloth layer. Because microfiber cleaning cloths according to the invention exhibit very desirable properties for wet cleaning, in preferred embodiments of the cleaning pad the base layer comprises an absorbent material, e.g. a water absorbent material, such as foamed polymers, sponges or the like.

Due to their advantageous properties the microfiber cleaning cloths and the cleaning pads according to the invention are particularly suitable for cleaning, e.g. wet cleaning, large surface areas, in particular in conjunction with a flat-headed cleaning support. Accordingly, an additional aspect of the present invention is the provision of a cleaning implement comprising: a cleaning support member, said cleaning support member having a substantially flat bottom surface; and a microfiber cleaning cloth or a cleaning pad according to the invention releasably attached to cleaning support.

Another aspect of the present invention is the provision of a kit comprising:

a cleaning support member, said cleaning support member having a substantially flat bottom surface; and

a microfiber cleaning cloth or a cleaning pad according to the invention.

Embodiments in accordance with the invention as well as further advantages will be described in the following with reference to the following drawings.

Brief Description of the Drawings

Figures 1a to f show diagrams illustrating preferred piqué knitting patterns for use in microfiber cleaning cloths in accordance with the invention.

Figures 2a and b show diagrams illustrating preferred second knitting patterns for use in preferred embodiments of microfiber cleaning cloths in accordance with the invention.

Figure 3 shows the surface structure of a preferred embodiment of a microfiber cleaning cloth knitted with a Lacoste pattern.

Figure 4 shows the surface structure of a preferred embodiment of a microfiber cleaning cloth knitted with a Lacoste pattern and a second knitting pattern.

Figure 5 shows the surface structure of a knitted microfiber cleaning cloth known in the art.

Figures 6 to 9 are cross-sectional views of four different, preferred embodiments of a cleaning pad.

Figures 10 and 11 show isometric views of a preferred embodiment of a cleaning implement. In Figure 10, the embodiment is shown in a collapsed state, while in Figure 11, in an extended state.

Figure 12 shows an isometric view of the preferred embodiment shown in Figures 10 and 11 provided with a handle.

Figure 13 represents a schematic view of an experimental setup used to measure the drag of a sample.

Detailed Description

The details and embodiments of the present invention are best understood by reference to the drawings.

Microfiber cleaning cloth

Microfiber cleaning cloths according to the invention are knitted with a pattern comprising a piqué knitting pattern, preferably using a circular or flat bed knitting machine, more preferably circular rib machine, most preferably a circular rib double knit machine. A piqué knitting pattern means a knitting pattern which yields a knitted cloth having, on at least one side of the knitted cloth, a waffle-patterned structure. Preferred piqué knitting patterns include Lacoste, Honeycomb, French piqué, Swiss piqué, single piqué and Ottoman-Honeycomb patterns, all of which are well known in the art. In Figures 1a to 1f, said preferred piqué knitting patterns are diagrammed, illustrating the yarn path **30** as well as dial needles **101,102** and cylinder needles **201,202** of the yarn feeds (**1-4, 1-6, 1-8** or **1-12** as the case may be).

In Figure 1a the Lacoste knitting pattern, a rib gating pattern, is illustrated. The pattern is based on an eight feed repeat as follows: Feed No. 1 knit all cylinder needles **201,202** and tuck odd dial needles **101**; Feed No. 2 knit all dial needles **101, 102**; Feed No. 3 knit all cylinder needles **201,202** and tuck odd dial needles **101**; Feed No. 4 knit all dial needles **101,102**; Feed No. 5 knit all cylinder needles **201,202** and tuck even dial needles **102**; Feed No. 6 knit all dial needles **101,102**; Feed No. 7 knit all cylinder needles **201,202** and tuck even dial needles **102**; and Feed No. 8 knit all dial needles

101,102. The surface structure of a preferred embodiment of a microfiber cleaning cloth knitted with a Lacoste pattern is shown in Figure 3.

Figure 1b shows the Honeycomb knitting pattern. This pattern, a rib gating pattern, is a modified Lacoste knitting pattern and is also based on an eight feed repeat. Feeds 1, 3 to 5, 7 and 8 are the same as the Lacoste knitting pattern, while Feed No. 2 includes knitting even dial needles **102** and Feed No. 6 knitting odd dial needles **101**.

In Figure 1c, the French piqué knitting pattern is illustrated. This pattern, a rib gating pattern, is based on a four feed repeat as follows: Feed No. 1 knit even dial needles **102**; Feed No. 2 knit all cylinder needles **201, 202** and odd dial needles **101**; Feed No. 3 knit odd dial needles **101**; Feed No. 4 knit all cylinder needles **201,202** and knit even dial needles **102.**

The Swiss piqué pattern, a rib gating pattern, is illustrated in Figure 1d. This pattern is based on a four feed repeat as follows: Feed No. 1 knit all cylinder needles **201, 202** and odd dial needles **101**; Feed No. 2 knit even dial needles **102**; Feed No. 3 knit all cylinder needles **201,202** and knit even dial needles **102**; and Feed No. 4 knit odd dial needles **101**.

The single piqué pattern, an interlock gating pattern, is illustrated in Figure 1e. This pattern is based on a six feed repeat as follows: Feeds No. 1 and No. 5 knit even cylinder needles **202** and even dial needles **102**; Feeds No. 2 and No. 4 knit odd cylinder needles **201** and odd dial needles **101**; Feed No. 3 knit even cylinder needles **202** and tuck even dial needles **102**; and Feed No. 6 knit odd cylinder needles **201** and tuck odd dial needles **101**.

In Figure 1f, the Ottoman-honeycomb pattern, an interlock gating pattern, is illustrated. This pattern is based on a twelve feed repeat as follows: Feeds No. 1 and No. 3 knit even cylinder needles **202** and even dial needles **102**; Feeds No. 2, No. 4, No. 6, No. 8, No. 10 and No. 12 knit odd cylinder needles **201** and odd dial needles **101**; Feeds No. 5, No. 7, No. 9 and No. 11 knit even cylinder needles **202**.

A gauge greater than or equal to 18 needles per inch is typically used on the knitting machine, preferably in the range of 18 to 28 needles per inch, more preferably 20 needles per inch.

Preferably, the microfiber cleaning cloth is knitted with a pattern comprising a piqué knitting pattern and a second knitting pattern. Preferably, the second knitting pattern is not a piqué knitting pattern. Suitable patterns for the second knitting pattern include knitting patterns, which provide a cloth having either a flat or non-dimpled structure. Examples of preferred patterns for the second knitting pattern include Milano Rib and Ponte di Roma pattern, both of which are well known in the art.

In Figure 2a, the Milano Rib pattern, a rib gating pattern, is illustrated. This pattern is based on a three feed repeat as follows: Feed No. 1 knit all cylinder needles **201,202** and all dial needles **101,102**; Feed No. 2 knit all cylinder needles **201,202**; and Feed No. 3 knit all dial needles **101,102**.

The Ponte di Roma pattern, an interlock gating pattern, is illustrated in Figure 2b. This pattern is based on a four feed repeat as follows: Feed No. 1 knit odd cylinder needles **201** and odd dial needles **101**; Feed No. 2 knit even cylinder needles **202** and even dial needles **102**; Feed No. 3 knit all cylinder needles **201,202**; and Feed No. 4 knit all dial needles **101,102**.

For mixed patterns comprising a piqué knitting pattern and a second knitting pattern, any suitable pattern sequence is useful. However, preferred pattern sequences include the following: two consecutive repeats of the piqué knitting pattern followed by two consecutive repeats of the second knitting pattern; two consecutive repeats of the piqué knitting pattern followed by one repeat of the second knitting pattern, or one repeat of the piqué knitting pattern followed by two consecutive repeats of the second knitting pattern. A pattern sequence of one repeat of the piqué knitting pattern followed by two consecutive repeats of the second knitting pattern is more preferred.

The microfiber cleaning cloths are knitted with at least one microfiber-containing yarn. Other yarns, such as ground yarns, i.e. yarns, which do not comprise microfibers

and often provide structural support for microfiber-containing yarns, may also be used in the manufacture of the microfiber cleaning cloths. Preferably, the microfiber cleaning cloths are knitted from microfiber-containing yarn and ground yarn. For example, for a microfiber cleaning cloth knitted with a pattern comprising Lacoste knitting pattern, it is preferred that microfiber-containing yarns are applied in feed numbers 1, 4, 5 and 8, while ground yarns are applied in feed numbers 2, 3, 6 and 7 of the Lacoste pattern.

It will be appreciated that the microfiber-containing yarn is comprised of fibers wherein each such fiber is a collection of distinct microfibers. The microfibers are preferably nylon and/or polyester microfibers, which typically render the cleaning cloth oleophilic as well as hydrophilic. Each yarn preferably comprises between about 10 and 90% by weight nylon microfibers and between about 90 and 10% by weight polyester microfibers, more preferably comprising about 70 to 80% by weight polyester microfibers and about 20 to 30% by weight nylon microfibers. The microfibers in the individual fibers of the yarn can be observed (e.g., microscopically) as alternating elongate layers or as wedge or pie shaped segments, for example, extending longitudinally along the lengths of the individual fibers. The microfiber-containing yarn may have a linear density between about 40 and 300 denier per yarn, preferably about 150 denier per yarn. "Linear density" or "fineness", in referring to yarns or to individual fibers, refers to the weight in grams of a 9,000 meter length of the fiber or yarn.

Ground yarn may comprise any of a variety of fibrous materials such as polyester (e.g., polyethylene terephthalate), nylon, rayon, cotton, and the like. Because of cost, commercial availability, and its ability to provide a web material that is desirably soft, the ground yarn preferably comprises polyester fibers, most preferably polyethylene terephthalate (PET) fibers. The ground yarn may have a linear density between about 40 and 300 denier per yarn, preferably about 150 denier per yarn. Suitable commercially available polyester yarns include those available from DuPont of Wilmington, Delaware, comprising about 34 fibers per yarn with a linear density of about 150 denier per yarn.

Water-soluble yarns may also be advantageously used in the knitting and/or the manufacture of the microfiber cleaning cloth. Water-soluble yarn may include such yarns comprising polyvinyl alcohol ("PVA"), carboxy methyl cellulose thread, carboxy ethyl cellulose thread, alginate fiber, and combinations of the foregoing materials. Yarns comprised of PVA are preferred and suitable PVA yarns will have linear densities within the range from about 1 to 300 denier per yarn and typically will comprise any number of threads and/or fibers per yarn as long as the yarn remains processable in the knitting process. Suitable commercially available PVA yarns include a PVA yarn available from Nichibi KK of Japan having a linear density of about 40 denier per yarn.

When a water-soluble yarn is used, the water-soluble yarn is preferably dissolved out of the knitted cloth during the manufacture of the microfiber cleaning cloth. During this process, the fiber structure of microfiber-containing yarn tends to delaminate or split so that the individual fiber structures, and the structures of the yarns originally made with those fibers, may no longer be observable within the cloth when observed under a microscope, for example. Instead of yarns of the original fibers, the individual microfibers may be seen arranged in distinct bundles woven into the cloth web and supported by the ground yarns. The bundles appear as a collection of individual microfibers arranged side by side and appearing substantially parallel to and conterminous with one another. Depending on the composition of the microfibers, the presence of bundles may render the microfiber web material hydrophilic as well as oleophilic. The microfiber cleaning cloths in accordance with the invention preferably comprise microfibers present in bundles. For such preferred microfiber cleaning cloths knitted from yarn comprising polyester and nylon microfibers, each bundle preferably comprises between about 10 and 90% by weight nylon and between about 90 and 10% by weight polyester, and more preferably comprising about 70 to 80 % by weight polyester and about 20 to 30 % by weight nylon.

For preferred embodiments of the microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern and a second knitting pattern, preferably a water-soluble yarn is used in the second knitting pattern during the manufacture of the cloth. Microfibers in the portions of the microfiber cleaning cloth knitted with the second

knitting pattern are preferably present in bundles. More preferably, microfibers in the portions of the microfiber cleaning cloth knitted with the second knitting pattern are present in bundles, while the portions of the microfiber cleaning cloth knitted with the piqué knitting pattern are substantially free (more preferably free) of microfibers in the form of bundles. In such preferred embodiments, the portions of the microfiber cleaning cloth knitted with the piqué knitting pattern may be free of microfiber-containing yarn. More desirably, for such preferred embodiments, the portions of the microfiber cleaning cloth knitted with the piqué knitting pattern comprise microfiber-containing yarn and the structure of the microfiber-containing yarn is observable within said portions of the cloth when the cloth is examined under a microscope.

A method for manufacturing a microfiber cleaning cloth according to the invention comprises the step of knitting a cloth with a pattern comprising a piqué knitting pattern, preferably a pattern comprising a piqué knitting pattern and a second knitting pattern, using at least one microfiber-containing yarn. The manufacture of a knitted cloth preferably comprises first knitting a greige cloth which is formed with a yarn containing microfibers, preferably microfibers of polyester and nylon; a ground yarn, preferably a polyethylene terephthalate yarn; and, if desired, a water-soluble yarn, preferably comprising polyvinyl alcohol. "Greige cloth" refers to an unfinished cloth that, upon further processing, may be used as a microfiber cleaning cloth of the present invention. After the knitting step is completed, the greige cloth is preferably cleaned by the application of hot water (e.g., greater than 60°C, preferably between 70 and 100°C) to remove dirt, oil, etc. picked up by the cloth during the knitting step. In the case that a water-soluble yarn was used in the knitting step, this yarn will be dissolved from greige cloth during the cleaning step. When a water-soluble yarn is used, it can be advantageous to perform the cleaning step twice. After the cleaning step, if desired, the cloth may be dyed. The cloth may then optionally be stretched and/or optionally be heat set (e.g. heating at temperatures within the range from about 120°C to about 180°C typically for about 30 seconds or more, preferably from about 30 seconds to about 360 seconds). The thus prepared web may then be used as a microfiber cleaning cloth.

The microfiber cleaning cloths according to the invention exhibit desirably low drag and good cleaning efficiency during wet or damp cleaning. The microfiber cleaning cloths also exhibit good cleaning efficiency for cleaning or wiping in the dry state. Thus, the microfiber cleaning cloths can be advantageously used alone for wiping or cleaning a surface, or they can be advantageously used as part of a cleaning article, such as a cleaning pad; a cleaning implement, e.g. a cleaning implement disclosed in commonly assigned co-pending EP application No. 01105948.2 filed March 9, 2001; or the like.

Cleaning pad

Cleaning pads according to the invention comprise a wiping layer comprising a microfiber cleaning cloth according to the invention. The wiping layer is typically the portion of the cleaning pad that contacts the surface during cleaning.

As shown in Figure 6, the cleaning pad **40** preferably comprises two layers, a wiping layer **41** and a base layer **42** adjacent to the wiping layer. The base layer **42** may be formed from any of a variety of materials capable of supporting the wiping layer **41** and providing a means to grasp the cleaning pad during a cleaning application (e.g,, dusting or wet wiping) or to attach the cleaning pad to a cleaning support. Preferably the base layer **42** comprises a material, which is also suitable for cleaning operations, so that the cleaning pad **40** is reversible and both the wiping layer **41** and the base layer **42** can each perform cleaning functions.

Suitable materials for the base layer **42** include absorbent materials, e.g. water absorbent materials; nonwoven materials, e.g. nonwoven webs of fibers; fleece materials and the other materials conventionally used in cleaning pads or for cleaning. Suitable absorbent materials include sponges, e.g. cellulose sponges; foamed polymers, e.g. foamed polyurethane or polyester; and pile materials, such as materials comprising polymer, e.g. polyester, fibers having a length of about 1 cm on a backing. Suitable nonwoven materials include nonwoven webs of fibers, which are useful for scouring applications, are described in WO 97/49326. Among suitable nonwoven web materials, open, low density, three-dimensional, nonwoven web of fibers, the fibers bonded to one another at points of mutual contact, are preferred. Such materials are

described by Hoover et al. in U.S. Patent No. 2,958,593. Because the microfiber cleaning cloth exhibits advantageous properties for wet cleaning, the base layer **42** preferably comprises an absorbent material, more preferably a foamed polymer or a pile material. In preferred embodiments of the cleaning pad **40** in which the base layer **42** comprises a pile material, it is preferred that the pile of the said material faces inwards towards the wiping layer.

Also as shown in Figure 7, the cleaning pad may be comprise a third layer **43**, which is adjacent to the base layer **42**. Suitable materials for the third layer **43** include a microfiber cleaning cloth according to the invention or other materials suitable for cleaning, such as those described for the base layer. In such preferred embodiments of the cleaning pad **40** comprising three layers, the base layer **42** preferably comprises an absorbent material and the third layer **43** comprises a nonwoven web of fibers. Such embodiments of the cleaning pad **40** are advantageously suited for dry, damp and wet cleaning as well as scouring with a single cleaning pad. For use with a cleaning support of a cleaning implement, the third layer **43** may comprise a material suitable for attaching the cleaning pad **40** to the support, such as loop material (e.g. for use with fastening hooks), polymer-based cloth and the like. Although not preferred, the base layer **42** may comprise two or more sub-layers.

The layers of the cleaning pad may be joined together in any conventional manner known in the art, e.g. by adhesive bonding, stitching or the like. Alternatively, as shown in Figure 8, the wiping layer **41** may be wrapped around the base layer **42** in a continuous loop of material that is dimensioned to retain the base layer within the loop of material without adhesives. As illustrated in Figure 9, the wiping layer **41** may be wrapped around the edges of the base layer **42** or any other layer **43** adjacent to the base layer **42**, to provide a rolled edge **45**, which may be held in place by stitching around the perimeter of the cleaning pad **40**.

The cleaning pad **40** is preferably substantially rectangular or substantially trapezoidal in shape. Other shapes of cleaning pad **40** may be employed, round, elliptical, triangular, as needed to accommodate a particular cleaning application or may

otherwise be desired. Due to the advantageous properties of the microfiber cleaning cloths of the invention, discussed above and below, the cleaning pad is particularly advantageous for cleaning large surface areas, and for use with or attachment onto a cleaning support of a cleaning implement. Thus, it is preferred that the cleaning pad 40 comprises a wiping surface having an area greater than 110 cm^2, more preferably, greater than 200 cm^2, even more preferably greater than 300 cm^2, most preferably greater than 400 cm^2. Under the term "wiping surface" is understood the exposed surface of the cleaning pad for application onto a surface to be cleaned.

Cleaning implement

As illustrated by a preferred embodiment of the cleaning implement shown in Figures 10 and 11, the cleaning implement in accordance with the invention **60** comprises a cleaning support member **50** and a microfiber cleaning cloth or, preferably, a cleaning pad **40**. The construction and the materials of the microfiber cleaning cloth or the cleaning pad are the same as the construction and the materials of the various foregoing embodiments of the microfiber cleaning cloth or cleaning pad.

The cleaning implement **60** preferably further comprises a handle **70** which is attached to the cleaning support member **50**, as shown in Figure 12.

The cleaning support member **50** and the handle **70** may be made of any suitable rigid, durable material, such as wood, metal, plastic or combinations of these materials. Plastic is preferred since it can be molded into a finished piece and thereby may be less expensive to manufacture. The length of the handle **70** will be dictated by the end-use of the implement, e.g. 1 to 2 meters for a cleaning floors and 2 to 3.5 meters for cleaning walls, windows or ceilings. Preferably the handle **70** is a telescope handle as known in the art, whereby the length of the handle can be set as desired or needed for a particular cleaning application. The handle **70** is preferably removably attached to the cleaning support member **50**. To facilitate ease of use, the cleaning support member **50** can be pivotably attached to the handle **70** using joint assemblies known in the art. The top surface **54** of the cleaning support member **50** typically comprises a central connection hub **55** to facilitate attachment of a handle **70**.

As shown in Figures 10 and 11, the cleaning support member **50** may be formed from two plates **51,52** with a hinged member **53** disposed between the two plates (i.e. a butterfly-type cleaning support member), which may facilitate the attachment of the cleaning pad **40** to the support member **50**. Alternatively, the cleaning support member **50** may be formed from a single plate. As shown in Figure 11, the cleaning support member **50** has a substantially flat bottom surface **56**.

The bottom, i.e. plate or hinged plates, of the cleaning support member **50** is preferably, substantially rectangular or substantially trapezoidal in shape. For household purposes the cleaning support member **50** is preferably at least about 6 cm by 20 cm, more preferably at least about 7.5 cm by 27 cm, most preferably at least about 9 cm by 35 cm. For industrial cleaning purposes, a larger size for the cleaning support member **50** is preferred, more preferably at least about 12 cm by 40 cm, even more preferably at least about 14 cm by 50 cm, most preferably at least about 15 cm by 60 cm. Other shapes and sizes of cleaning support member **50** may be employed, round, elliptical, triangular, as needed to accommodate a particular cleaning application or may otherwise be desired.

For embodiments of the cleaning implement comprising a cleaning support member **50** and a cleaning pad **40**, the cleaning pad preferably has a similar shape as the bottom of the cleaning support member. As shown in Figures 10 to 12, the cleaning pad **40** preferably extends a short distance in all directions beyond the perimeter of the bottom surface of the cleaning support member **50**. The cleaning pad **40** can be releasably attached to the cleaning support member **50** by any suitable means known in the art. For example, the cleaning pad **40** may be provided, on the side opposite of the wiping layer **41**, with attachment pockets **46** or straps (not shown) made of an elastic material, which allow the releasable attachment of the cleaning pad to the cleaning support member **40**. Alternatively, the bottom surface of the cleaning support member **50** may comprise fastening hooks which facilitate the releasable attachment of a cleaning pad **40**. In this case, the outer layer of the cleaning pad opposite of the wiping layer **41** preferably comprises a material, such as a loop material, which is

directly, releasably attachable to the fastening hooks. Suitable fastening hooks and loop materials are well known in the art.

For embodiments of the cleaning implement comprising a cleaning support member and a microfiber cleaning cloth of the invention, the cleaning support member may further comprise push-type fasteners on the top surface of the support or other types of fasteners, which facilitate the releasable attachment of a microfiber cleaning cloth to the cleaning support member. Alternatively, the microfiber cleaning cloth can be simply wrapped around the cleaning support member in a similar manner as a conventional mop cloth.

The cleaning implement can be advantageously constructed from a kit comprising a cleaning support member and a microfiber cleaning cloth or a cleaning pad. The kit preferably further comprises a handle, which is attachable to the cleaning support member. The construction and the materials of the cleaning support member, the microfiber cleaning cloth or the cleaning pad as well as the handle for use in a kit are the same as the construction and the materials for the corresponding element of the various foregoing embodiments of the invention.

Test methods

Test method for determination of efficiency of fine dust pick-up

Efficiency of a cleaning cloth in picking up fine dust was determined by measuring the amount of fine dust taken up by the cleaning cloth in a dry state. In particular, 0.400 g of fine dust (grain size 125 micrometer and less) including walnut shells, pumice, aluminum oxide mineral, flint mineral and yellow iron pigment was spread over three 30 by 30 cm ceramic tiles. After mounting the cleaning cloth (50 cm by 20 cm) on a flat-headed test support, the tiles were wiped with the cloth with a single pass, i.e. one forward and one backward stroke. The residual dust on the tiles was then picked up with a pre-weighed disposable microfiber cloth (typically having a weight about 2 g). The disposable cloth was then re-weighed to determine the weight of residual dust. The amount of dust picked up by the cleaning cloth was determined by subtracting the

weight of the residual dust from 0.400 g. Efficiency was then computed, i.e. amount of dust picked up by the sample in grams divided by 0.400 g and expressed in percent.

Test method for determination of efficiency of oil removal

Efficiency of a cleaning cloth in oil removal was determined by comparing the measured gloss value of a clean glass surface to the gloss value of same glass surface measured after soiling the surface with oil and wiping with the cloth. In particular, the 60° gloss of a clean glass surface (30 cm by 30 cm) was measured using a reflectometer (commercially available under the trade designation MICRO-GLOSS 60° Reflectometer from BYK Labotron Messtechnik AG, Lausitzerstrasse 8, D-8192 Geretsried, Germany) at two positions: a first position, i.e. "position zero", and a second position 5 cm displaced along the surface from position zero, i.e. "position five". Subsequently one drop of oil (0.27g) was placed on the glass surface at position zero.

Samples, i.e. 5 cm by 7 cm, of the cleaning cloth to be tested were prepared. A sample was then mounted on a flat test support (5 cm by 7 cm in size, 580 g in weight). The sample was then (centrally) placed in contact with the oil drop at position zero and displaced 20 cm along the glass surface over position five and back to position zero. One such cycle of forward and backward displacement or wiping was defined as a pass. After 1, 3, 5, 10 and 15 passes, the 60° gloss was measured at position zero and position five. Efficiency was then computed for each position, i.e. gloss value after wiping divided by initial gloss value and expressed in percent. Gloss values were measured at position five to confirm that oil was actually removed by wiping with the sample, not simply distributed over the glass surface.

Oil removal was tested with samples of the cleaning cloth in the dry state as well as in the damp state. For testing in the damp state, before mounting the sample to the test support, the sample was dipped in water and the excess water was removed with a squeeze roller in order to obtain a constant level of water from one sample to another.

Test method for determination of drag

As illustrated in Figure 13, drag was measured by determining the force needed to drag a sample of the cleaning cloth **90** over a glass surface **91** at set speed and displacement using a Instron Dynamometer Model 1011(from Instron SA, Parc Ariane, F-78280 Guyancourt) **92** equipped with a traction system **93** using a pulley **94** plus a load range cell of 0.50 kN **95** and equipped with a data processor **96**.

H-shaped samples, i.e. 120 mm by 190 mm rectangles having 40 mm by 40 mm exclusions centered on the two narrow sides, were prepared. A sample was dipped in water and the excess water was removed with a squeeze roller in order to obtain a constant level of water from one sample to another. The wet sample was then mounted on a flat test support **97** (made of polyacrylate); the dimensions of the bottom of support was 108 by 118 mm. The mounted sample was then weighed down using weight(s) **98** to yield a total weight of 685 g for the sample and support. After calibration of the load step with 5 kg and 1 kg weights and attachment of the test support to the traction system, the sample was then dragged over a displacement of 150 mm at a crosshead speed of 400 mm/min. The force necessary to drag the sample was measured and computed in units of N. Each sample was measured twice and the results averaged.

Materials used

1. (Comparative) microfiber cleaning cloth, product available under the trade designation "SCOTCH-BRITE High Performance Cloth" from Minnesota Mining and Manufacturing Co., St. Paul, Minnesota, USA (referred to here as "HPW-Material"),
- a cloth knitted with a non-piqué pattern comprising yarn comprising microfibers of polyester and nylon (70 % polyester and 30% nylon) as well as ground yarn of polyester; both yarns having a linear density of 150 denier. The microfibers in the cloth are arranged in bundles. The surface structure of the HPW-Material is shown in Figure 5; the bundles of microfibers are visible as tuft-like structures.

2. Microfiber cleaning cloth knitted with a Lacoste knitting pattern comprising yarn comprising microfibers of polyester and nylon (70 % polyester and 30% nylon) as well as ground yarn of polyester; both yarns having a linear density of 150 denier

(referred to here as "Lacoste-Material"). In reference to the Lacoste knitting pattern illustrated in Figure 1a, the microfiber-containing yarns were used in Feed Nos. 1, 4, 5 and 8 and ground yarns in Feed Nos. 2, 3, 6 and 7. The microfibers in the cloth are not arranged in bundles, i.e. the structure of the microfiber-containing yarn is observable within the cloth when the cloth is examined under a microscope. The surface structure of the Lacoste-Material is shown in Figure 3.

3. Microfiber cleaning cloth knitted with a mixed pattern having a pattern sequence of one repeat of Lacoste knitting pattern (as described above for the Lacoste Material) followed by two consecutive repeats of a non-piqué knitting pattern (i.e. that used for the HPW material). (This material is referred to here as "Mixed-Material".) The Mixed-Material comprises yarn comprising microfibers of polyester and nylon (70 % polyester and 30% nylon) as well as ground yarn of polyester; both yarns having a linear density of 150 denier. In the portions of the Mixed Material knitted with the second knitting pattern, the microfibers are arranged in bundles, while in the portions knitted with the Lacoste knitting pattern the microfibers are not arranged in bundles. The surface structure of the Mixed-Material is shown in Figure 4.

Test Results

Efficiency of fine dust pick-up:

For each cleaning cloth tested, three individual samples were tested as described above and the results for the amount of dust picked up by three samples averaged. Efficiency based on the averaged value for dust pick-up was calculated. The results are reported in the following Table.

Sample	Dust picked up by sample (g)				Efficiency, %
	Sample 1	Sample 2	Sample 3	Average	
HPW-Material	0.360	0.385	0.365	0.370	92.5 %
Lacoste-Material	0.339	0.334	0.334	0.336	84.0 %
Mixed-Material	0.347	0.342	0.381	0.357	89.3 %

The results of fine dust pick-up testing show that the microfiber cleaning cloth knitted with the Lacoste pattern or the mixed pattern exhibits good or very good efficiency in dust pick-up. The cleaning efficiency of the Mixed material is comparable to that observed for the HPW material.

Efficiency of oil removal

For each cleaning cloth, efficiency of oil removal was tested in both dry and damp state as described above. Efficiency of oil removal after the corresponding passes was computed as described above, and the results are reported in the following Tables.

Sample tested in dry state	Position	Efficiency (%) after given number of passes				
		1 pass	3 passes	5 passes	10 passes	15 passes
HPW-Material	0	76.54	90.83	95.52	96.91	97.23
	5	76.95	90.07	93.28	96.16	96.58
Lacoste-Material	0	81.02	81.02	80.17	78.90	79.74
	5	84.98	78.27	78.81	77.95	79.95
Mixed-Material	0	88.95	87.42	87.32	87.32	88.38
	5	90.20	88.64	88.00	88.00	87.30

Sample tested in damp state	Position	Efficiency (%) after given number of passes				
		1 pass	3 passes	5 passes	10 passes	15 passes
HPW-Material	0	84.97	86.56	87.09	88.57	87.83
	5	85.44	86.72	86.29	84.38	87.61
Lacoste-Material	0	84.14	86.05	86.05	87.42	87.74
	5	82.94	85.17	85.17	85.91	85.50
Mixed-Material	0	86.93	83.41	84.96	86.88	86.56
	5	85.13	82.03	83.69	85.56	84.71

The results of testing show that the microfiber cleaning cloth knitted with the Lacoste pattern or the mixed pattern exhibits good or very good efficiency in oil removal in

the dry state. In the damp state, the microfiber cleaning cloth knitted with the Lacoste pattern or the mixed pattern exhibits very good efficiency in oil removal, comparable to that of the HPW material.

Drag Value

Three series of measurements were performed, in each case determining the force needed to drag the sample of the cleaning cloth over the test surface as described above, with two different sets of samples. The results are reported in the following Table:

Sample	Drag value (N)		
	First Series	Second Series	Third Series
HPW-Material	3.24	3.28	3.32
Lacoste-Material	1.10	1.19	1.19
Mixed-Material	1.65	1.74	1.74

The results of testing show that the microfiber cleaning cloth knitted with the Lacoste pattern or the mixed pattern exhibits very low drag and that the observed drag values for these cloths are significantly lower than that of the HPW material.

The results of the drag measurements together with the results of the cleaning efficiency tests show that the microfiber cleaning cloth knitted with the Lacoste pattern or the mixed pattern exhibits a significant lower drag in comparison to a conventional microfiber cleaning cloth, while maintaining good or comparable cleaning efficiency.

Claims

1. A microfiber cleaning cloth knitted with a pattern comprising a piqué knitting pattern.

2. A microfiber cleaning cloth according to claim 1, wherein the piqué knitting pattern is selected from the group consisting of Lacoste, Honeycomb, French piqué, Swiss piqué, single piqué and Ottoman-Honeycomb pattern.

3. A microfiber cleaning cloth according to claim 1 or claim 2, wherein said pattern further comprises a second knitting pattern.

4. A microfiber cleaning cloth according to claim 3, wherein the second knitting pattern is not a piqué knitting pattern.

5. A cleaning article comprising a microfiber cleaning cloth according to any one of claims 1 to 4.

6. A method for manufacturing a microfiber cleaning cloth comprising the step: knitting a cloth with a pattern comprising a piqué knitting pattern using at least one microfiber-containing yarn.

7. A method for manufacturing a microfiber cleaning cloth according to claim 6, wherein said pattern further comprises a second knitting pattern.

8. A method of cleaning a surface comprising wiping the surface with a microfiber cleaning cloth according to any one of claims 1 to 4.

9. A cleaning pad comprising:

a wiping layer comprising a microfiber cleaning cloth according to any of claims 1 to 4.

10. A cleaning pad according to claim 9, wherein the cleaning pad further comprises a base layer adjacent to the wiping layer.

11. A cleaning pad according to claim 10, wherein the base layer comprises an absorbent material.

12. A cleaning implement comprising:

a cleaning support member, said cleaning support member having a substantially flat bottom surface; and

a microfiber cleaning cloth according to any one of claims 1 to 4 or a cleaning pad according to any one of claims 9 to 11 releasably attached to said cleaning support member.

13. A kit comprising:

a cleaning support member, said cleaning support member having a substantially flat bottom surface; and

a microfiber cleaning cloth according to any one of claims 1 to 4 or a cleaning pad according to any one of claims 9 to 11.

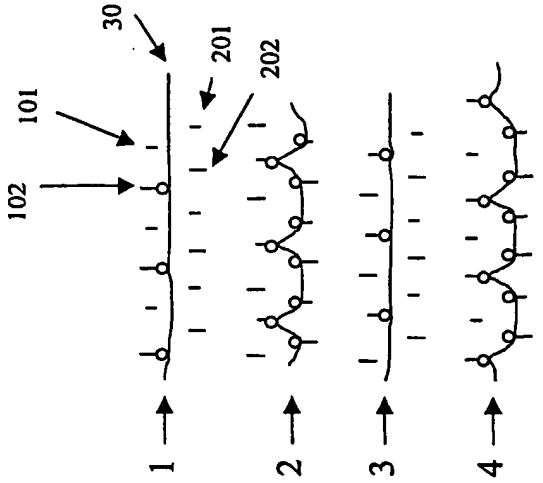


Fig. 1c

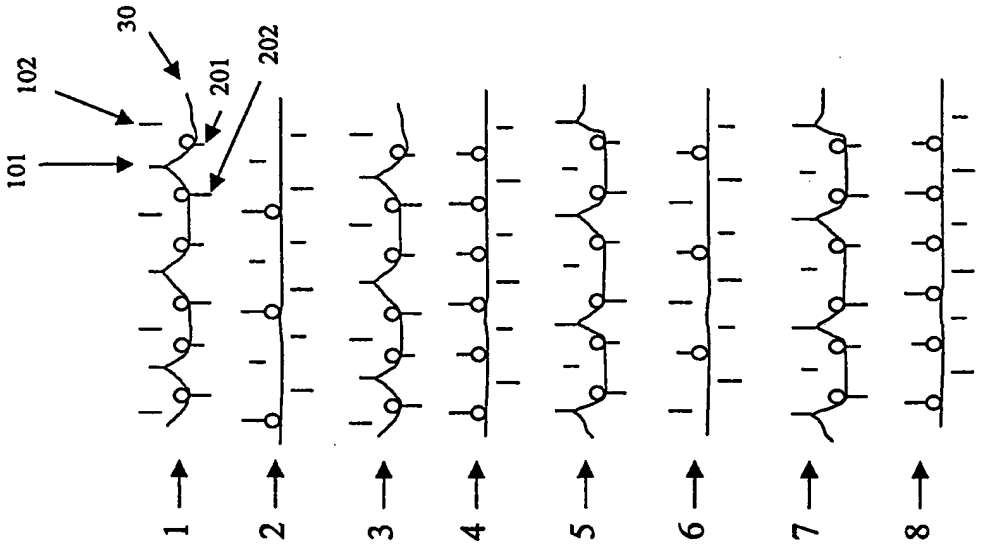


Fig. 1b

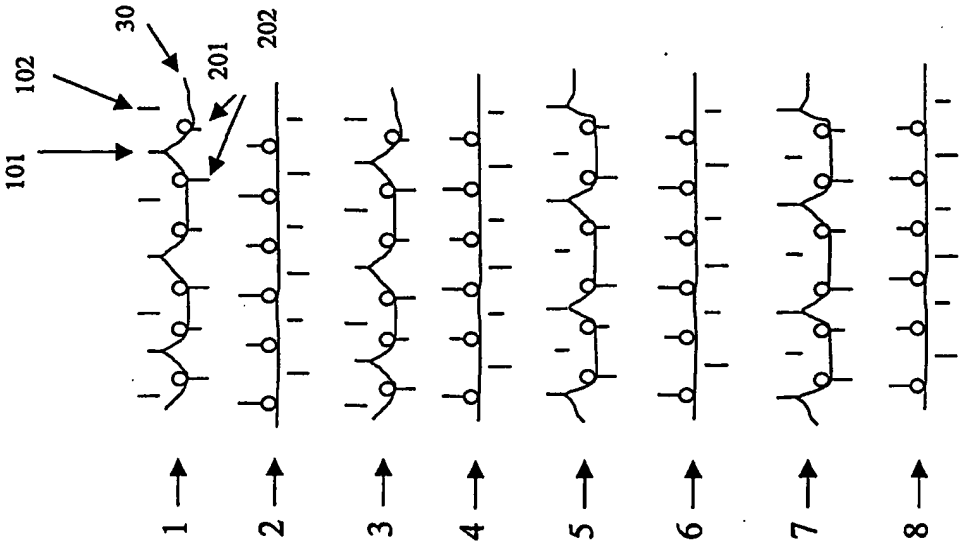


Fig. 1a

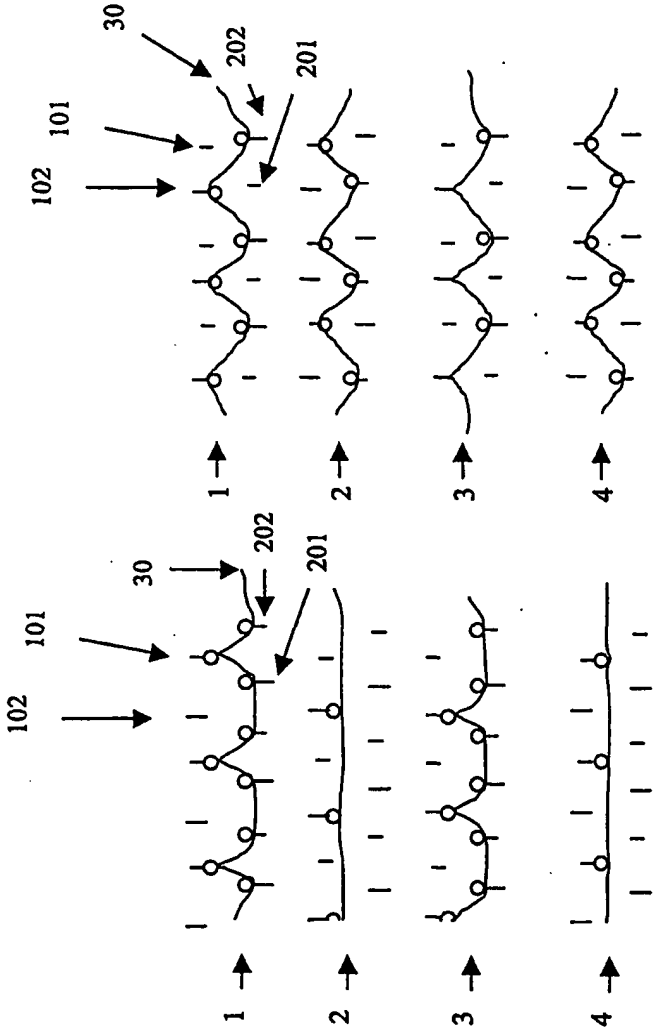


Fig. 1d

Fig. 1e

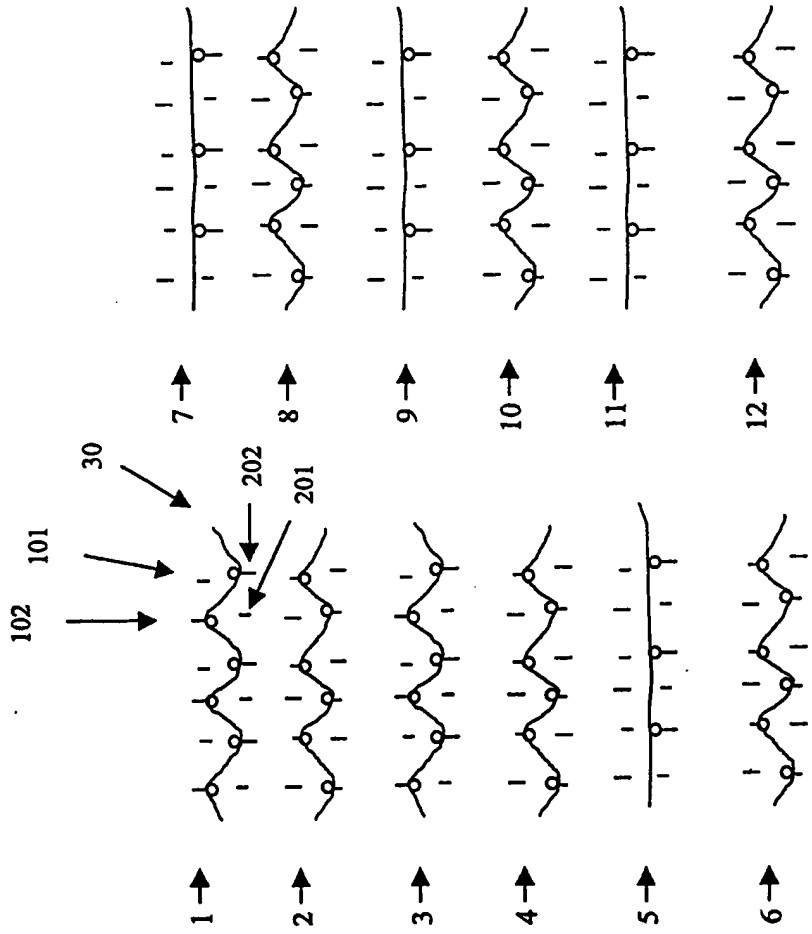


Fig. 1f

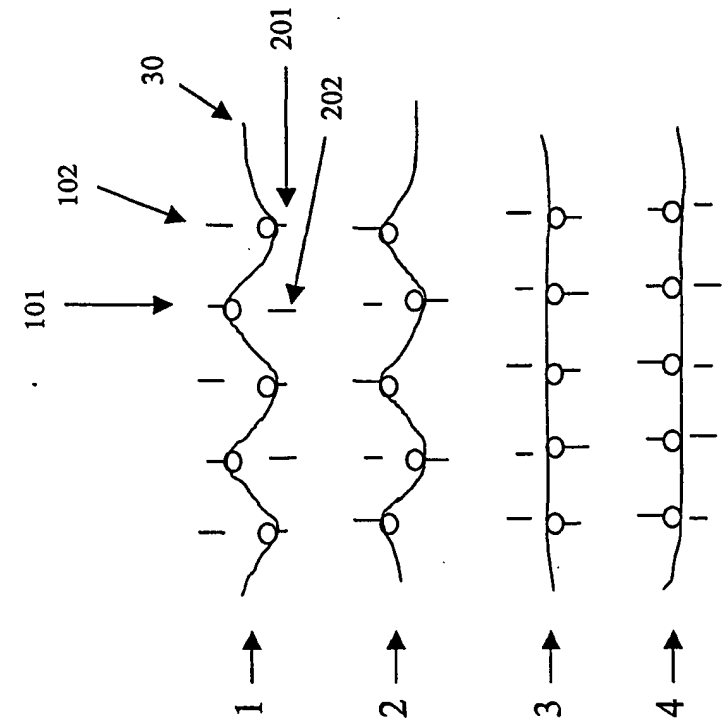


Fig. 2b

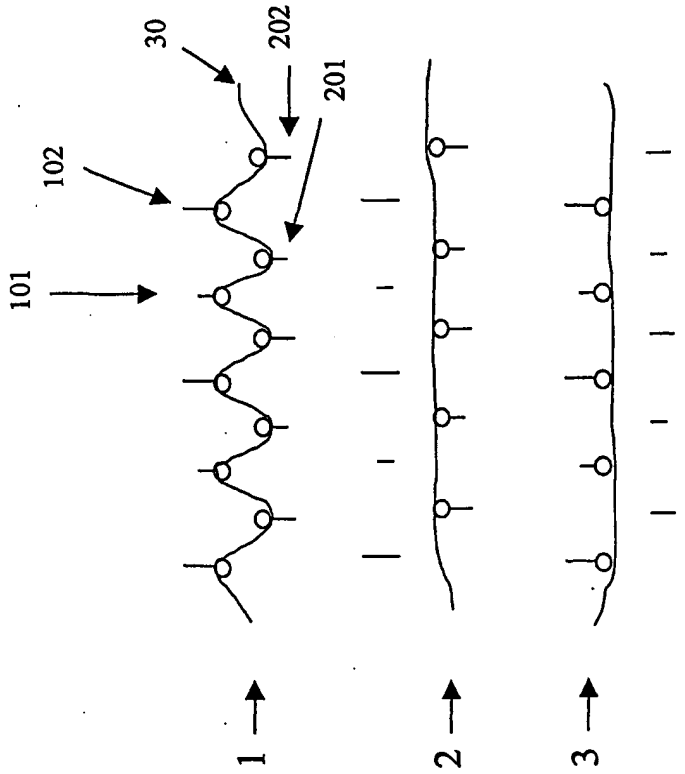


Fig. 2a

Fig. 3

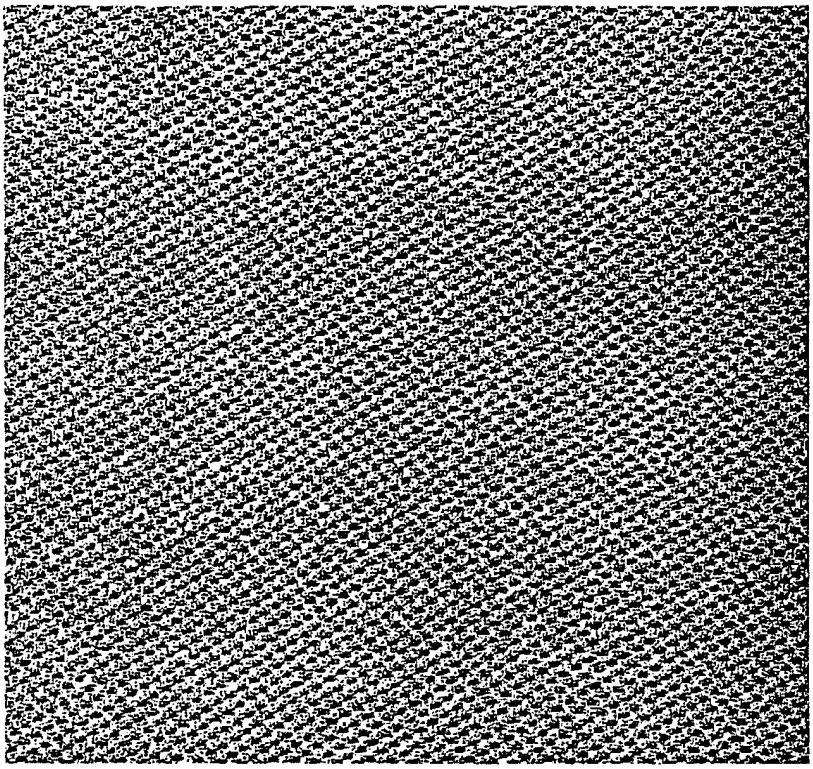
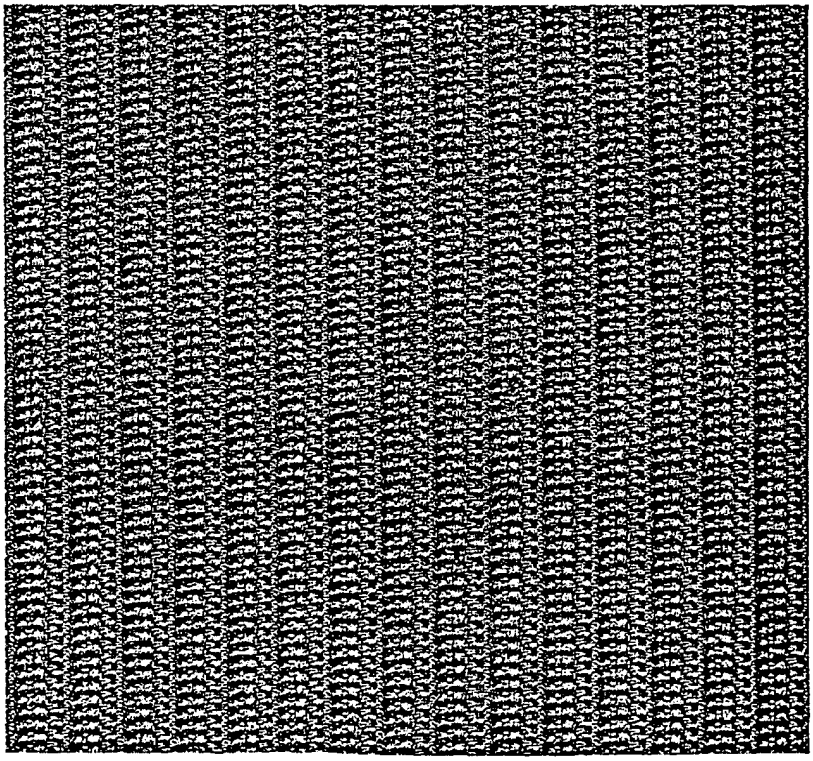


Fig. 4



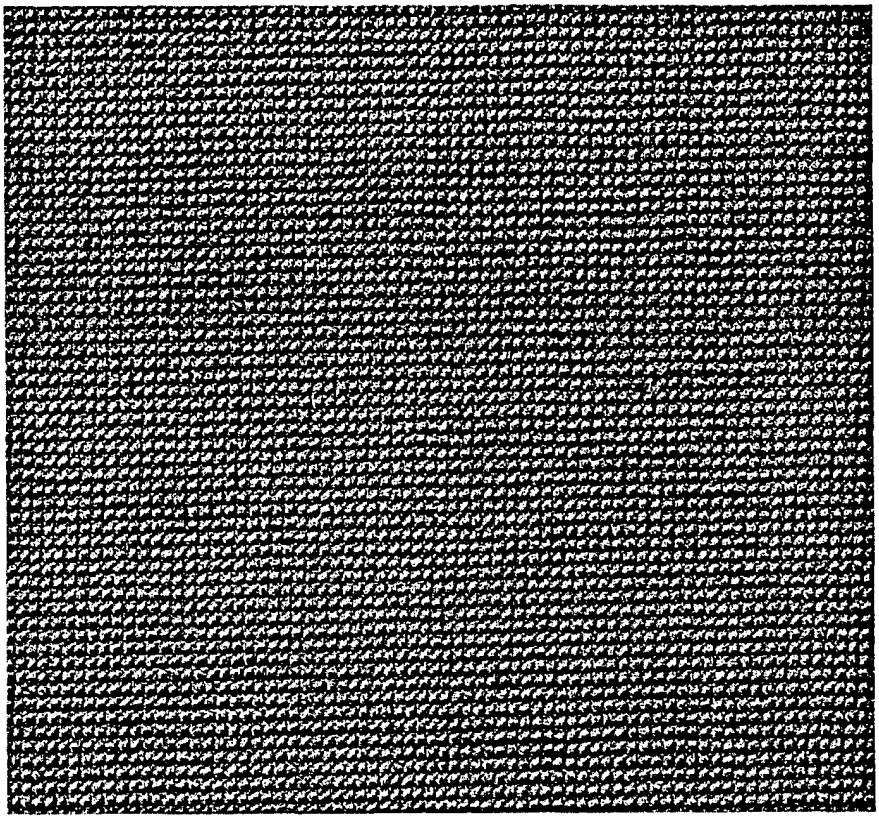


Fig. 5

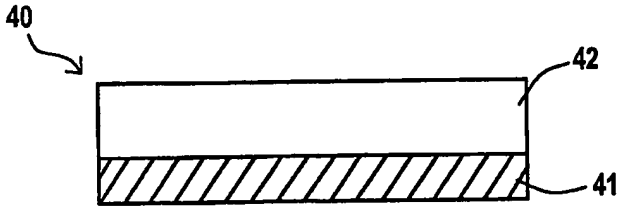


Fig. 6

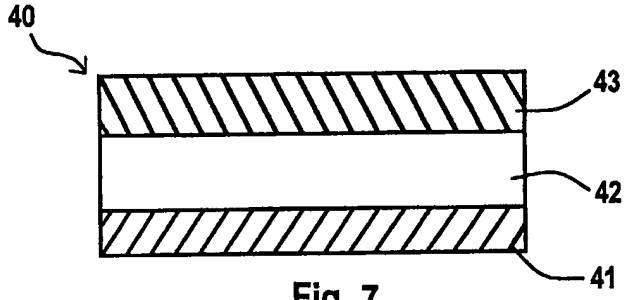


Fig. 7

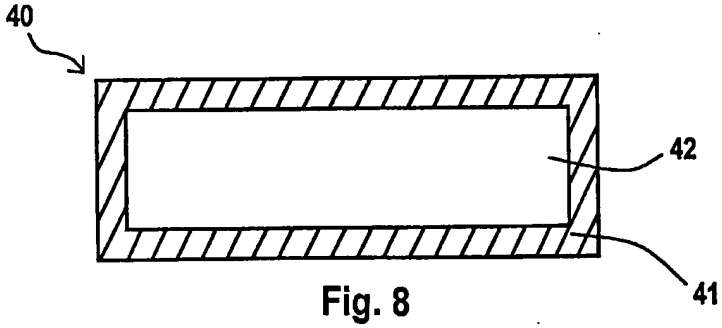


Fig. 8

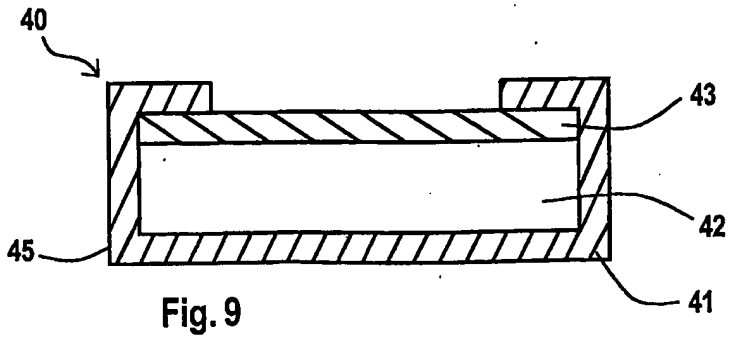


Fig. 9

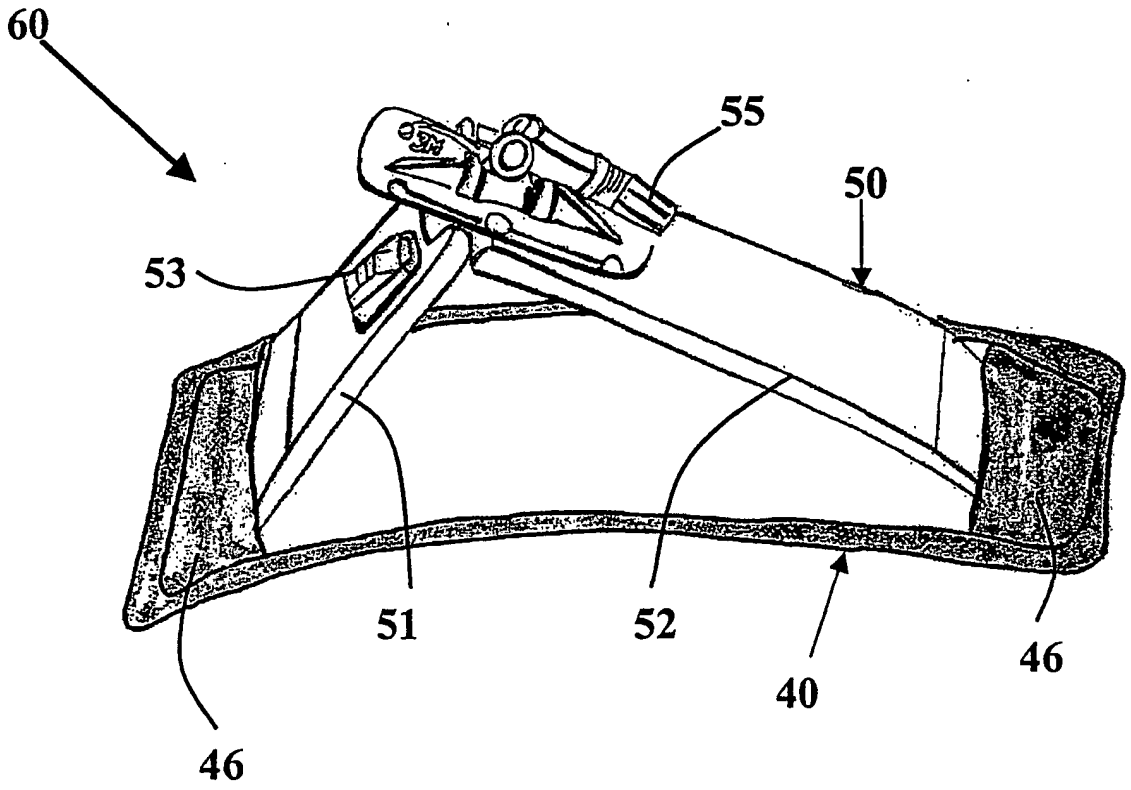


Fig. 10

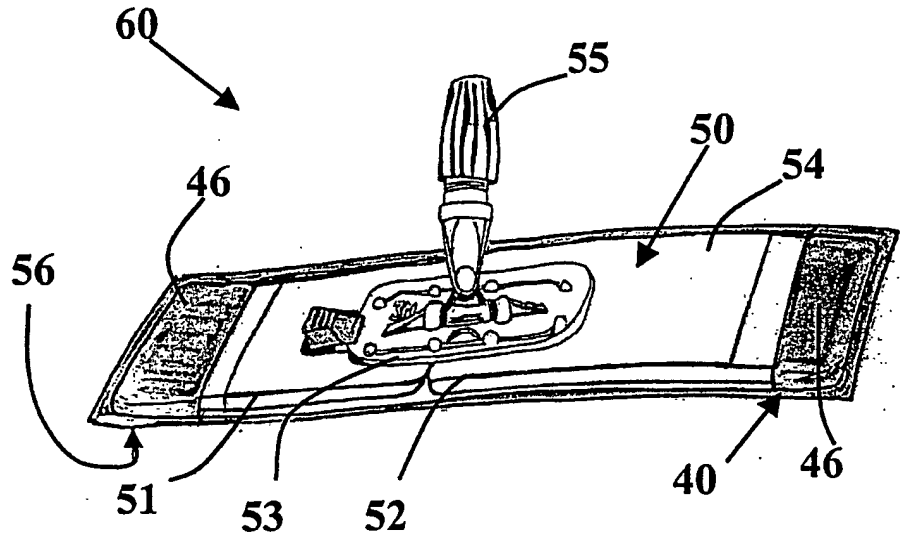


Fig. 11

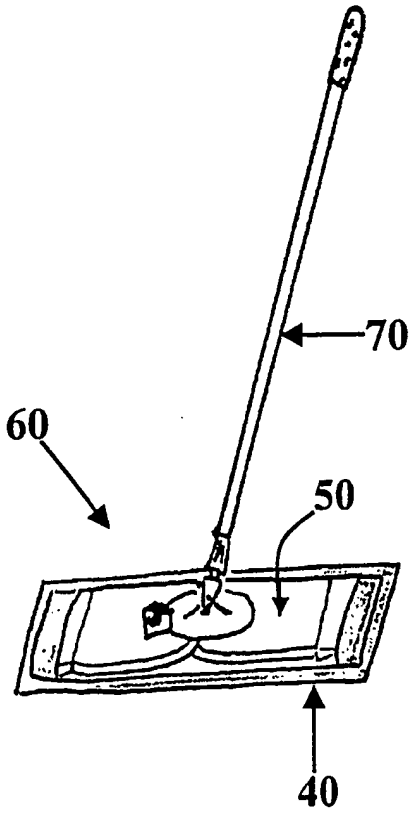


Fig. 12

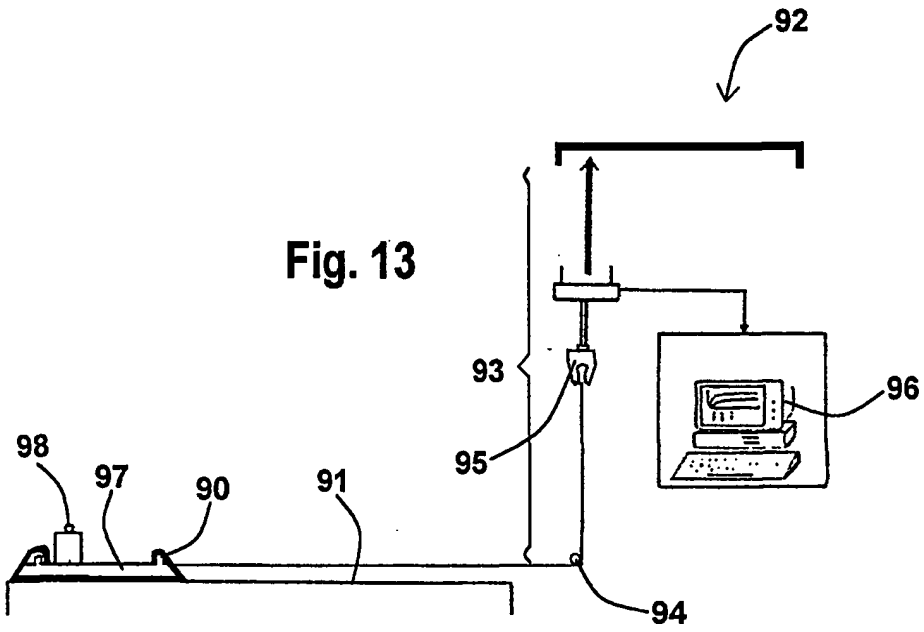


Fig. 13

INTERNATIONAL SEARCH REPORT

Inter ial Application No
PC1/1B 01/00609

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04B1/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04B A47L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 809 806 A (KIM BYUNG JOO ET AL) 22 September 1998 (1998-09-22) claims 1,4,5; figures 1-5; example 1	1,5,6, 8-10
A	DE 200 12 226 U (GRABARITS DIETER) 14 December 2000 (2000-12-14) page 2, line 3 - line 8 page 4, line 16 - line 20; claim 1; figures 1-4	1,5,6,8, 9,12,13
A	WO 96 10946 A (ACTUELLE TRICOT I BORAAS AB ;NORDIN RUDOLF (SE)) 18 April 1996 (1996-04-18) page 7, line 25 -page 8, line 12; claims 1,2; figures 1-3	1,5,6, 8-13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 December 2001	02/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Van Gelder, P

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INTERNATIONAL SEARCH REPORT

Interna al Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 99 62393 A (NORDIN RUDOLF ;ACT AB (SE)) 9 December 1999 (1999-12-09)	
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